CLAIMS

We claim:

1. A method for treating a metal-containing liquid, wherein the metal-containing liquid also comprises reducing agents, the method comprising:

providing a reaction vessel containing an anode, a cathode, and a hydrogen ion-permeable membrane separating the anode and the cathode;

disposing the metal-containing liquid to be treated in the reaction vessel in contact with the anode;

disposing a catholyte solution in contact with the cathode;

a first placing of the anode and cathode in electrical communication with a power source and driving an electrical current through the anode and the cathode until at least a majority of the reducing agents in the metal-containing liquid are oxidized to create an intermediate liquid and a used catholyte solution;

removing the used catholyte solution from contact with the cathode and the intermediate liquid from contact with the anode, optionally from the reaction vessel separately to a first and a second reservoir respectively;

disposing the intermediate liquid in contact with the cathode;

disposing an anolyte solution in contact with the anode; and

a second placing of the anode and cathode in electrical communication with a power source and driving an electrical current through the anode and the cathode until a majority of the metal ions in the intermediate liquid are plated onto the cathode to provide a treated solution.

2. The method of claim 1, wherein the catholyte solution is a solution of a non-electrochemically reactive salt, having an approximately equivalent ionic concentration as the metal-containing liquid.

3. The method of claim 2, wherein the catholyte solution is a ferric sulfate solution and the used catholyte solution is a ferrous sulfate solution.

4. The method of claim 3, additionally comprising regenerating a ferric sulfate solution from the ferrous sulfate solution by bubbling a gas through the ferrous sulfate solution, wherein the gas is selected from the group consisting of air and oxygen.

5. The method of claim 3, wherein the anolyte solution is a solution of approximately equal ionic concentration as the intermediate liquid, selected from the group consisting of sodium salt solutions and sulfate salt solutions.

6. The method of claim 5, wherein the anolyte solution is selected from the group consisting of sodium sulfate and ferrous sulfate.

7. The method of claim 1, wherein the anolyte solution is a solution of approximately equal ionic concentration as the intermediate liquid, selected from the group consisting of sodium salt solutions and sulfate salt solutions.

8. The method of claim 7, wherein the anolyte solution is selected from the group consisting of sodium sulfate and ferrous sulfate.

9. The method of claim 1, wherein the electrical current in at least one of the first and second placing of the anode and cathode in electrical communication with a power source is between about 1 ampere and about 10 amperes.

10. A method for treating a metal-containing liquid, wherein the metal-containing liquid also comprises reducing agents, the method comprising:

providing a reaction vessel containing an anode, a cathode, and a hydrogen ion-permeable membrane separating the anode and the cathode;

disposing the metal-containing liquid in the reaction vessel in contact with the cathode;

disposing an anolyte solution in the reaction vessel in contact with the anode;

placing the anode and cathode in electrical communication with a power source and driving an electrical current through the anode and the cathode until at least a majority of the metal ions in the metal-containing liquid are plated onto the cathode to produce an intermediate liquid;

removing the intermediate liquid from contact with the cathode and the anolyte solution from contact with the anode, optionally from the reaction vessel separately to a first and a second reservoir respectively;

disposing the intermediate liquid in contact with the anode;

disposing a catholyte solution in contact with the cathode; and

a second placing the anode and cathode in electrical communication with a power source and driving an electrical current through the anode and the cathode until at least a majority of the reducing agents in the metal-containing liquid are oxidized to provide a treated solution.

11. The method of claim 10, wherein the catholyte solution is a solution of a ferric salt, having an approximately equivalent ionic concentration as the intermediate liquid.

12. The method of claim 11, wherein the ferric salt is ferric sulfate and the used catholyte solution is a ferrous sulfate solution.

13. The method of claim 12, additionally comprising regenerating a ferric sulfate solution from the ferrous sulfate solution by bubbling a gas through the ferrous sulfate solution, wherein the gas is selected from the group consisting of air and oxygen.

14. The method of claim 12, wherein the anolyte solution is a solution of approximately equal ionic concentration as the intermediate liquid, selected from the group consisting of sodium salt solutions and sulfate salt solutions.

15. The method of claim 14, wherein the anolyte solution is selected from the group consisting of sodium sulfate and ferrous sulfate.

16. The method of claim 10, wherein the anolyte solution is a solution of approximately equal ionic concentration as the intermediate liquid, selected from the group consisting of sodium salt solutions and sulfate salt solutions.

17. The method of claim 16, wherein the anolyte solution is selected from the group consisting of sodium sulfate and ferrous sulfate.

18. The method of claim 8, wherein the electrical current in at least one of the first and second placing of the anode and cathode in electrical communication with a power source is between about 1 ampere and about 10 amperes.